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The Mineral Industry of Saudi Arabia

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR • Donald Paul Hodel, Secretary

BUREAU OF MINES • Robert C. Horton, Director

This publication is a chapter from the current Bureau of Mines Minerals Yearbook, comprising *Volume I, Metals and Minerals; Volume II, Area Reports: Domestic; Volume III, Area Reports: International.* The separate volumes of the Yearbook are sold by the Superintendent of Documents, Washington, D.C. 20402.

The Mineral Industry of Saudi Arabia

By John R. Lewis[1]

Over one-fourth of the world's known reserves of crude oil are in the geologic structures beneath Saudi Arabia and its adjacent offshore waters. Saudi reserves are about one-third larger than those of the entire Western Hemisphere. Petroleum, thus, continued in 1984 to be the dominant force in Saudi Arabia's mineral economy as well as of its overall economy. Export revenues from crude and refined petroleum products and, increasingly, from petrochemicals comprised a large percentage of the national income. Because of its position as swing producer among its fellow members in the Organization of Petroleum Exporting Countries (OPEC) and because of continued reduced world demand for petroleum energy, exports of Saudi Arabia's crude and refined products for 1983 and 1984 combined were off 62% from the level of exports of crude and products in 1982.

Other minerals or mineral products that were important, but to a lesser degree than oil, included cement, iron and steel, and sulfur. Exploration for nonferrous minerals and startups of several modest mining operations in copper, gold, lead, and zinc were under way.

The gross domestic product stood at $108 billion[2] and was growing at an annual rate of about 7%. Total revenues to the Government were $53 billion while expenditures were $62 billion, resulting in a shortfall to be recovered by drawing on Saudi Arabia's estimated $155 billion overseas financial reserve; a course it was reluctant to allow to continue. The drive toward diversification of the economy continued and gains were made in the industrial and agricultural sectors. In this period of recession, the Government moved to minimize or eliminate wasteful and unproductive spending while allowing productive spending to continue.

Government Policies and Programs.—Having spent more than a decade in building a modern and highly efficient infrastructure that was in top condition and virtually completed by 1984, the Government began a campaign to spur the private sector into investing more in the economy, particularly in industry. Saudi Arabia's fourth 5-year plan called for privatization of several large state agencies including the General Petroleum and Mineral Organization (Petromin). One of the more important objectives of the plan was diversification of the national income and a reduction in dependence on oil for foreign exchange.

PRODUCTION AND TRADE

Crude petroleum production remained at drastically depressed levels as Saudi Arabia sought, within the framework of OPEC, to maintain production ceilings and agreed-upon prices. Accurate information on Saudi Arabia's daily crude output was not issued by the Government in 1984. Outside estimates ranged from 5.5 million barrels per day (bbl/d) to 4.2 million bbl/d, but an official statement, limited to the output for July and August only, stated that for those 2 months, output was much less.

Production of both iron and steel and cement rose in 1984 as the Saudi Iron and Steel Co. (Hadeed) plant went on full production and a ninth large cement plant went on-stream. Saudi Arabia was still reliant for about 40% of its cement upon foreign sources, mostly neighboring countries.

Exports of petroleum and petroleum products comprised 99% of Saudi Arabia's exports and were valued at $38.9 billion, down from $105.8 billion in 1981. Imports of all commodities also were down to $36.8 billion, and created a closer trade balance than had existed in many years.

Generally, Saudi Arabia was against any barter or countertrading transactions involving oil. During 1984, in what was described as an exceptional case, Saudi Arabia's national airline, Saudi, arranged to purchase 10 Boeing stretched 747 transport aircraft from the Boeing Co. of the United States. Price per plane was estimated to be $100 million, with one spare Rolls Royce jet engine per plane for $7 million additional. The $1.07 billion purchase was to be financed by the Saudi Government through sale of between 34 and 35 million barrels of Saudi crude oil, valued at official prices. Sale of the oil was to be handled by the Saudi national oil company, Petromin. It appeared that crude sales would be made only in sufficient quantity to pay for each plane as it was delivered.

The six-nation Gulf Cooperation Council (GCC), composed of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, protested tariffs imposed by the European Economic Community on imports of Saudi Arabian methanol coming from new petrochemical facilities beginning to produce that product in Saudi Arabia.

Table 1.—Saudi Arabia: Production of mineral commodities[1]

Commodity	1980	1981	1982	1983[p]	1984[e]
METALS					
Iron and steel: Steel, crude thousand metric tons	50	72	70	275	[2]842
NONMETALS					
Cement, hydraulic[3] do.	2,911	4,735	7,153	8,126	[2]9,000
Gypsum do.	[r]300	[r]350	363	500	[2]300
Lime[e] do.	150	175	170	9	[2]12
Nitrogen: N content of ammonia do.	167	170	207	225	410
Sulfur:					
Native metric tons	1,000	NA	NA	NA	NA
Byproduct, all sources do.	460,000	600,000	900,000	695,000	[2]833,000
Total do.	461,000	600,000	900,000	695,000	833,000
MINERAL FUELS AND RELATED MATERIALS[4]					
Gas, natural:					
Gross million cubic feet	1,935,407	1,880,071	1,200,000	[e]1,000,000	1,700,000
Marketed[e] do.	450,000	500,000	400,000	383,500	1,100,000
Natural gas liquids: All forms thousand 42-gallon barrels	135,139	163,582	159,769	[e]125,000	[2]130,000
Petroleum:					
Crude do.	3,613,683	3,579,920	2,309,428	1,834,100	1,606,000
Refinery products:					
Gasoline do.	26,043	29,000	39,000	[e]50,000	36,000
Jet fuel do.	11,800	13,500	16,700	[e]17,000	15,000
Kerosine do.	12,526	[r]10,300	9,000	[r e]9,000	10,000
Distillate fuel oil do.	47,700	[e]46,000	66,975	84,900	99,000
Residual fuel oil do.	89,048	[e]90,000	93,748	[e]90,000	80,000
Liquefied petroleum gas do.	97,339	[e]100,000	57,243	[e]50,000	60,000
Naphtha do.	45,560	[e]47,000	36,850	[e]32,000	35,000
Asphalt do.	8,268	[e]8,300	14,125	[e]16,000	5,000
Unspecified do.	1,600	[e]1,700	2,000	[e]3,000	3,500
Refinery fuel and losses[e] do.	10,200	10,500	10,000	9,000	10,000
Total do.	350,084	[r e]356,000	[r e]345,641	[r e]360,900	353,500

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through Oct. 15, 1985.
[2]Reported figure.
[3]Data are for the Hejira calendar year, which corresponds closely to the Gregorian calendar year.
[4]Includes Saudi one-half share of production in the Kuwait-Saudi Arabia Partitioned Zone.

Table 2.—Saudi Arabia: Exports of selected mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity		1982	1983
METALS			
Aluminum: Metal including alloys:			
Scrap		6,946	NA
Unwrought		62	NA
Semimanufactures		244	NA
Copper:			
Matte and speiss including cement copper		110	NA
Metal including alloys:			
Scrap		8,013	NA
Semimanufactures		152	NA
Iron and steel:			
Iron ore and concentrate, pyrite, roasted		2,000	NA
Metal:			
Scrap		28,680	NA
Pig iron, cast iron, related materials		269	NA
Steel, primary forms		98	NA
Semimanufactures:			
Bars, rods, angles, shapes, sections		2,561	NA
Universals, plates, sheets		2,452	NA
Rails and accessories		455	NA
Tubes, pipes, fittings		4,498	NA
Lead: Metal including alloys, all forms		r1,094	NA
Zinc:			
Ore and concentrate		107	NA
Metal including alloys:			
Scrap		240	NA
Unwrought		193	NA
Semimanufactures		467	NA
NONMETALS			
Abrasives, n.e.s.: Grinding and polishing wheels and stones		23	NA
Asbestos, crude		798	NA
Cement		527,301	NA
Clays, crude: Unspecified		88	NA
Diatomite and other infusorial earth		81	NA
Fertilizer materials:			
Crude, n.e.s.		542	NA
Manufactured:			
Nitrogenous		340,764	NA
Phosphatic		4,473	NA
Unspecified and mixed		38	NA
Graphite, natural		25	NA
Gypsum and plaster		38,361	NA
Lime		3,991	NA
Pigments, mineral: Iron oxides and hydroxides, processed		31	NA
Salt and brine		2,000	NA
Sodium compounds, n.e.s.: Carbonate, manufactured		8	NA
Stone, sand and gravel:			
Dimension stone:			
Crude and partly worked		1,116	NA
Worked		3,161	NA
Gravel and crushed rock		182,651	NA
Sand other than metal-bearing		364	NA
Sulfur:			
Elemental:			
Crude including native and byproduct		131	NA
Colloidal, precipitated, sublimed		415,946	NA
Sulfuric acid		234	NA
Other: Crude		3,660	NA
MINERAL FUELS AND RELATED MATERIALS			
Asphalt and bitumen, natural		14,760	NA
Carbon black		13	NA
Coal:			
Anthracite		7	NA
Briquets of anthracite and bituminous coal		219	NA
Lignite including briquets		33	NA
Gas, natural: Gaseous	million cubic feet	578,688	NA
Petroleum:			
Crude	thousand 42-gallon barrels	2,024,172	[2]1,658,925
Refinery products:			
Liquefied petroleum gas	do.	127,286	117,530
Gasoline, motor	do.	34,902	37,230
Kerosine and jet fuel	do.	33	12,045
Distillate fuel oil	do.	16,637	70,810
Lubricants	do.	506	1,825
Residual fuel oil	do.	18,876	93,075

rRevised. NA Not available.
[1]Table prepared by Virginia A. Woodson.
[2]Includes partly refined.

Table 3.—Saudi Arabia: Imports of selected mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity	1982	1983	Sources, 1983	
			United States	Other (principal)
METALS				
Alkaline- and rare-earth metals	1,500	2,770	45	United Kingdom 1,033; Sweden 800; Kenya 299.
Aluminum:				
Ore and concentrate	114,856	142,686	--	India 97,226; Romania 22,781; Australia 22,675.
Oxides and hydroxides	541	393	69	France 101; West Germany 37; unspecified 184.
Ash and residue containing aluminum	--	436	NA	Netherlands 280; United Kingdom 69.
Metal including alloys:				
Scrap and unwrought	r6,381	14,629	NA	Bahrain 7,151; Spain 3,392; Canada 1,445.
Semimanufactures	44,446	60,642	3,809	Greece 16,342; France 5,746; Italy 4,449.
Arsenic: Metal including alloys, all forms	98	129	--	West Germany 103; France 16.
Cobalt:				
Oxides and hydroxides	74	154	--	United Kingdom 146.
Metal including alloys, all forms	--	196	42	Italy 89; Taiwan 21; Spain 12.
Copper: Metal including alloys:				
Scrap	215	77	43	Japan 16; unspecified 18.
Unwrought	39	58	20	Italy 22; France 16.
Semimanufactures	26,459	28,678	4,407	Australia 11,045; Japan 3,641; United Kingdom 1,937.
Gold: Metal including alloys, unwrought and partly wrought troy ounces	638,995	738,180	--	Switzerland 498,271; West Germany 112,849; United Kingdom 115,871.
Iron and steel:				
Iron ore and concentrate excluding roasted pyrite	95,695	294,656	--	Brazil 181,098; Sweden 68,085; India 44,470.
Metal:				
Scrap	1,278	--		
Pig iron, cast iron, related materials	196,940	377,853	846	Brazil 201,810; Sweden 78,652; India 26,179.
Ferroalloys	356	140	7	West Germany 64; Taiwan 33; France 16.
Steel, primary forms	229,385	214,296	991	Japan 94,891; Finland 34,592; Republic of Korea 18,575.
Semimanufactures:				
Bars, rods, angles, shapes, sections thousand tons	3,362	2,972	3	Japan 1,369; Republic of Korea 564; Brazil 256.
Universals, plates, sheets do.	736	559	10	Japan 416; West Germany 49; Republic of Korea 32.
Rails and accessories do.	73	23	2	United Kingdom 11; West Germany 5; Japan 2.
Wire do.	55	90	(2)	West Germany 31; Japan 15; Republic of Korea 11.
Tubes, pipes, fittings do.	1,032	1,028	68	Japan 501; Italy 95; West Germany 73.
Castings and forgings, rough do.	48	93	16	United Kingdom 18; India 10; West Germany 8.
Lead:				
Ore and concentrate	313	158	--	Mainly from Morocco.
Oxides	247	214	NA	West Germany 87; unspecified 127.
Metal including alloys:				
Scrap	1,044	844	--	United Kingdom 473; Lebanon 106; Kuwait 97.
Unwrought	892	731	--	Jordan 386; Kuwait 265.
Semimanufactures	2,538	9,719	296	United Kingdom 6,497; West Germany 2,001.
Magnesium: Metal including alloys, semimanufactures	155	--		
Manganese:				
Ore and concentrate, metallurgical-grade	2,605	7,424	--	Norway 5,880; France 1,444.
Oxides	31	159	110	NA.
Mercury 76-pound flasks	348	638	87	Turkey 116; United Kingdom 29; unspecified 377.
Molybdenum: Ore and concentrate[3]	789	1,001	230	France 183; Belgium-Luxembourg 171.
Nickel: Metal including alloys, semimanufactures	288	360	18	Italy 177; Taiwan 72; West Germany 44.

See footnotes at end of table.

Table 3.—Saudi Arabia: Imports of selected mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity	1982	1983	Sources, 1983	
			United States	Other (principal)
METALS —Continued				
Platinum-group metals: Metals including alloys, unwrought and partly wrought, unspecified value, thousands	$19	--		
Silver: Metal including alloys, unwrought and partly wrought[4] troy ounces	104,683	24,370	3,651	Switzerland 10,579; West Germany 7,942.
Tin: Metal including alloys:				
Scrap	55	34	--	Singapore 25; Malaysia 9.
Semimanufactures	1,328	3,263	609	Japan 1,317; West Germany 1,125.
Titanium: Oxides	3,184	4,277	2,003	United Kingdom 974; Belgium-Luxembourg 440.
Uranium and thorium: Metal including alloys, all forms value, thousands	$84	--		
Zinc:				
Ore and concentrate	242	514	--	Czechoslovakia 317; West Germany 171.
Oxides	686	898	24	West Germany 372; Czechoslovakia 225; United Kingdom 144.
Metal including alloys:				
Scrap	--	1,153	--	Japan 466; United Kingdom 199; Czechoslovakia 180.
Unwrought	1,861			
Semimanufactures	16,715	15,646	89	Japan 6,721; Belgium-Luxembourg 2,571; West Germany 2,536.
Other:				
Ores and concentrates	198	207	15	Netherlands 77; unspecified 104.
Oxides and hydroxides	--	215	19	West Germany 156.
Ashes and residues	--	436	--	Netherlands 280; United Kingdom 69.
Base metals including alloys, all forms	229	--		
NONMETALS				
Abrasives, n.e.s.:				
Natural: Corundum, emery, pumice, etc	17	306	31	NA.
Grinding and polishing wheels and stones	3,352	3,208	179	Italy 1,571; West Germany 276; Japan 273.
Asbestos, crude	15,882	8,801	465	Canada 4,028; Botswana 2,361; Cyprus 832.
Barite and witherite	46,699	73,459	551	Thailand 51,536; Ireland 9,500; Greece 6,180.
Boron materials:				
Crude natural borates	27	387	123	West Germany 255.
Elemental	360	339	71	Japan 177; Italy 65.
Bromine	1,965	2,729	211	United Arab Emirates 1,537; West Germany 456.
Cement thousand tons	10,612	15,543	3	Spain 6,028; Japan 5,166; Greece 2,744.
Chalk	3,445	3,995	NA	Belgium-Luxembourg 1,256; France 647; Italy 584.
Clays, crude: Fire clay	30,171	23,189	11,888	India 4,169; Bulgaria 4,000; West Germany 1,258.
Cryolite and chiolite	38	111	111	
Diamond:				
Gem, not set or strung value, thousands	$1,914	$2,001	--	India $900; Belgium-Luxembourg $384; Italy $321.
Industrial stones do	$145	$471	--	India $193; Belgium-Luxembourg $114; Singapore $100.
Diatomite and other infusorial earth	49,756	10,518	1,488	Spain 3,693; Senegal 2,000; Italy 1,137.
Feldspar, fluorspar, related materials	965	1,136	NA	West Germany 831; France 300.
Fertilizer materials:				
Crude, n.e.s	28,666	89,594	5,248	West Germany 33,690; Netherlands 20,004; Italy 17,553.
Manufactured:				
Ammonia	727	588	83	Kuwait 283; Netherlands 89; United Kingdom 69.
Nitrogenous	44,905	73,497	1,522	France 19,177; Netherlands 18,404; Denmark 9,033.
Phosphatic	47,575	97,254	17,112	Belgium-Luxembourg 33,010; Finland 12,908; West Germany 6,140.
Potassic	7,936	29,119	260	Italy 18,500; Netherlands 4,976; United Kingdom 2,340.
Unspecified and mixed	18,948	21,793	1,276	Italy 5,500; Netherlands 3,144; Jordan 2,189.

See footnotes at end of table.

Table 3.—Saudi Arabia: Imports of selected mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity	1982	1983	Sources, 1983	
			United States	Other (principal)
NONMETALS —Continued				
Gypsum and plaster	59,140	96,788	3,780	West Germany 18,455; France 29,360; Yemen (Sanaa) 4,109.
Kyanite and related materials	3,582	3,937	125	West Germany 1,449; United Kingdom 1,354; India 512.
Lime	30,658	9,937	486	Lebanon 2,913; United Arab Emirates 1,620; France 684.
Magnesite	164	869	NA	Japan 632; Norway 90; West Germany 42.
Mica:				
Crude including splittings and waste	1,584	1,032	NA	India 922.
Worked including agglomerated splittings	203	109	80	West Germany 28.
Nitrates, crude	5,923	7,666	3,008	Italy 4,000; Finland 250.
Phosphates, crude	314	345	NA	United Kingdom 191; Netherlands 111.
Pigments, mineral:				
Natural, crude	2,756	5,667	2,536	India 682; West Germany 512; Turkey 472.
Iron oxides and hydroxides, processed	56,530	15,949	--	Qatar 15,019; West Germany 461.
Precious and semiprecious stones other than diamond:				
Natural value, thousands	$571	$766	--	West Germany $293; India $270; Taiwan $75.
Synthetic do	$1,121	$1,109	--	India $459; West Germany $341; Taiwan $176.
Pyrite, unroasted	97	190	38	West Germany 69; United Kingdom 30.
Salt and brine	18,049	20,665	12,156	United Kingdom 4,119; Netherlands 2,353.
Sodium compounds, n.e.s.:				
Carbonate, manufactured	42,460	60,226	13,350	Jordan 15,415; Belgium-Luxembourg 11,524.
Sulfate, manufactured	r8,569	10,164	317	West Germany 3,985; United Kingdom 3,008; Spain 700.
Stone, sand and gravel:				
Dimension stone:				
Crude and partly worked	46,315	64,578	293	Italy 50,880; Spain 1,688; Syria 974.
Worked	492,177	614,408	6,469	Italy 403,032; Greece 54,562; Spain 39,117.
Dolomite, chiefly refractory-grade	2,512	1,917	NA	France 815; Italy 275.
Gravel and crushed rock	336,972	284,497	4,650	United Arab Emirates 191,021; Italy 66,879.
Limestone other than dimension	31,789	798	NA	Netherlands 376; Turkey 300.
Quartz and quartzite	1,060	891	NA	Belgium-Luxembourg 402; West Germany 367.
Sand other than metal-bearing	6,787	7,846	965	Netherlands 3,623; Greece 1,174; Italy 429.
Sulfur:				
Elemental:				
Crude including native and by-product	900	287	NA	Iraq 272.
Colloidal, precipitated, sublimed	819	591	--	Kuwait 500; United Kingdom 60.
Sulfuric acid	2,424	1,191	64	Belgium-Luxembourg 436; Netherlands 322.
Talc, steatite, soapstone, pyrophyllite	927	1,876	90	India 466; Netherlands 267; Austria 243.
Other:				
Crude	6,025	--		
Slag and dross, not metal-bearing	541	--		
MINERAL FUELS AND RELATED MATERIALS				
Asphalt and bitumen, natural	3,606	2,764	1,835	United Kingdom 297; West Germany 140.
Carbon black	103	178	34	West Germany 22; Denmark 14; unspecified 94.
Coal: All grades including briquets	1,543	4,457	1,288	West Germany 2,284; Bangladesh 278.
Coke and semicoke	457	941	573	Malaysia 260.
Peat including briquets and litter	929	669	NA	Ireland 271; West Germany 197; United Kingdom 16.
Petroleum:				
Crude thousand 42-gallon barrels	5,774	1,627	770	NA.
Refinery products, lubricants do	r1,000	1,099	212	Netherlands 331; Singapore 217.

rRevised. NA Not available.
[1]Table prepared by Virginia A. Woodson.
[2]Less than 1/2 unit.
[3]May contain vanadium and tantalum ores.
[4]May include platinum-group metals.

COMMODITY REVIEW

METALS

In 1984, Saudi Arabia was engaged in active exploration for copper, gold, silver, and zinc, mostly in the Arabian Shield sector of the country. Some promise emerged also for tin and tungsten. Most of the work was done by the Deputy Ministry for Mineral Resources (DMMR) through its contractors, but there was also activity in and progress by the private sector. DMMR operated several exploration support facilities both in-house and under contract including three geochemical laboratories, a Remote Sensing Center, and computer services and drilling facilities.

Aluminum.—Following consultations with other members of the GCC, Saudi Arabia decided in May to temporarily shelve plans to build a 200,000-ton-per-year aluminum plant, presumably at or near other industrial development at Jubail in the Eastern Province. Saudi Arabia's Petromin said that the decision had been taken to head off "harmful competition" among GCC members. The opportunity for a viable aluminum industry in Saudi Arabia still exists, according to the Ministry. Bahrain and the United Arab Emirate, Dubai, already had aluminum smelters in operation with total aluminum metal capacity of 319,000 tons per year.

The Gulf Organization for Industrial Consulting was laboratory testing bauxite from the Az Zabirah deposit to determine its usability for making alumina; some of it proved convertible into alumina using the Bayer process. Based on close-spaced drilling of the deposit during the year, inferred reserves of 94,000 tons of 50% alumina were found. The reserves lie beneath 30 meters of overburden and were considered easily mined by open pit methods.

Copper.—Further exploration work was going forward during the year at the Jabal Sayid copper prospect. Spurred by sufficiently promising finds in underground drilling completed in July 1983, the DMMR authorized further tunneling and underground drilling into four ore bodies that were found. A 100-ton representative ore sample had been sent to Western Europe for pilot plant studies.

Gold.—The Government-owned Mahd adh Dhahab gold complex continued to take shape at a slow but steady pace. The 400-ton-per-day mine, first exploited about 900 B.C., is about 170 miles northeast of Jidda, and was under the overall design and development responsibilities of Gold Fields Mahd adh Dhahab Ltd. Saudi Arabia's DMMR awarded a contract to Alimah, a Swedish company, for seven assorted pieces of heavy mine development machinery for Mahd adh Dhahab during the year. It appeared likely that Marubeni Saudi Arabia Co. of Japan would furnish crushing and grinding plants valued at $15.2 million for the ore processing section of the complex.

Meanwhile, development of the Al-Masane gold-silver-copper-zinc mine, jointly owned by the Arabian Shield Development Co. of Dallas, Texas, and the National Mining Co. of Saudi Arabia, was proceeding well at the site in far southwest Saudi Arabia. A 60-ton ore sample was metallurgically tested to try to obtain maximum gold recovery. Beneficiation equipment was to be designed to yield a copper and a zinc concentrate while gold and silver will be recovered by carbon-in-pulp adsorption. Approval by the Saudi Arabian Government permitted a long-term, interest-free loan to the two companies for commercial-scale development of the Al-Masane property as well as a 30-year mining lease. The next phase was to be construction of the plant and commencement of full-scale mining, eventually at a rate of 500,000 tons per year. Arabian Shield Development and National Mining are joint owners-managers of the operation. Petromin had an option to acquire 25% of the ownership at an unspecified future date.

There were a number of other gold exploration operations in progress at various places in the Arabian Shield. An area known as Nugrah as Safra was licensed by Petromin to Boliden Mineral AB of Sweden, and exploration by Boliden continued in the areas around the Nugrah ancient minesite, about 75 miles northeast of Medina in the Arabian Shield.

In the summer of 1984, there were reports that the British firm International Exploration was mounting a search for gold in a 7,500-square-kilometer area in the Al Wajh quadrangle. Data gathered on earlier exploratory efforts using conventional methods were consulted, but the work was also benefiting from the use of new techniques for investigating the mineral potential of an area using infrared and other images gathered by the landsat satellite of the

U.S. National Aeronautics and Space Administration.

Iron and Steel.—Progress in mining various low-grade iron ore bodies at the Wadi Sawawin minesite in the far northwest sector of Saudi Arabia continued. The objective was to have a variety of ore body samples to run through the nearby pilot crushing facility and beneficiation plant. The mining phase was almost completed by yearend. The project was being conducted by the British Steel Corp. for the Saudi DMMR.

The pilot beneficiation plant, capable of treating 5 tons of raw ore per hour, was at Al Muhwaylih on the Red Sea coast, and was operating according to plan and making concentrates containing 62% iron and 68% iron in the feed. The goal was 65% iron with an accompanying 70% iron recovery. The flotation process in use at this plant had been devised by the U.S. Bureau of Mines Research Center at Minneapolis, Minnesota.

Primary market for the output of a full-scale beneficiation plant, should it be built, was the new Hadeed plant at Jubail on the Persian Gulf coast. Other potential markets under study were those in Egypt and Pakistan.

After having begun steel production early in 1983, the Hadeed plant reached its rated capacity of 850,000 tons per year during March 1984, about 15 months after startup. In that month, 72,000 tons of direct-reduced iron, 77,000 tons of billets, and 70,000 tons of bars and rods were produced. By yearend, the plant had produced a total of 842,000 tons of steel; 820,000 tons was sold to Saudi Arabian buyers. A goal of 1 million tons of finished steel had been set for 1985. The availability of inexpensive natural gas was expected to make Saudi Arabian steel production competitive in international markets, according to the Arab Iron & Steel Union.

Magnesium.—The Refractory Industry of Saudi Arabia, a trade association, was studying development of ways to obtain magnesium and magnesium compounds from 45% magnesium oxide ore and/or the seawater desalinization plants' salt wastes from the waters of the Red Sea and of the Arabian Gulf. The U.S. Bureau of Mines was assisting through provision of technical information.

Zinc.—The presence of zinc has been noted in a number of deposits in the country. Usually the ores are associated with other nonferrous metal ores as at Al-Masane, where copper, gold, silver, and zinc were found in the ore body. In July 1983, joint venture partners surrendered their gold-copper-zinc exploration license in the Umm Al Shalahib area because of the absence of gold in the deposits. This shortcoming made development uneconomical, the partners announced. However, in late 1984, Petromin confirmed the presence of zinc deposits at Umm Al Shalahib grading 15% to 18%. The site is about 150 miles southwest of Riyadh.

NONMETALS

Cement.—Production capacity in Saudi Arabia rose 20% by yearend, owing to the completion of additional facilities at the Yanbu plant of the Yanbu Cement Co. plus completion of an entirely new plant by the Arabian Cement Co. at Rabigh. The new 4,000-ton-per-day plant had four 1,000-ton-per-day capacity furnaces and a special filtering system to eliminate air pollution. This new project gave Saudi Arabia eight operating plants. Total capacity by yearend was 10,305,000 tons per year, still far short of a demand approximating 22 million tons per year. Under construction was an additional capacity of slightly more than 2 million additional tons, and still more was under study by consultants for the Saudi Cement Corp. plant at Hufuf.

Yamama Saudi Cement Co. Ltd. had a sixth line under construction at its Riyadh plant, which would virtually double that facility's capacity when completed in 1986. Among other features, the entire plant will then be a completely computer controlled system, which will include automation of the laboratory and of the cement dispatch system.

Oasim Cement Industries Co. contracted at midyear with Ishikawajima-Harima Heavy Industries Co. Ltd. of Japan to build a 730,000-ton-per-year cement plant at Burayadah, about 400 kilometers northwest of Riyadh. The plant cost was set at $110 million.

Sulfur.—The Red Sea Sulphur Corp. was formed in 1984 for Petromin by a subsidiary of Boliden AB of Sweden and unidentified Arabian partners. The firm completed a sulfur pelletizing plant in April at Uthmaniyah, west of Dhahran, which was working up to a planned feed rate of about 1,000 tons per day of liquid sulfur fed to the plant from the desulfurizing of crude oil at the Arabian-American Oil Co. (Aramco) Ras

Tanura refinery. Red Sea bought, pelletized, transported, and marketed the sulfur thus produced. The Boliden subsidiary, CONTECH, also supervised installations in the Jubail Harbor for storing and shiploading the sulfur and was to manage the entire operation for a minimum of 2 years.

Two sulfur recovery plants had been scheduled for completion and operation in 1984. The Petromin-Mobil Oil Corp. plant at Yanbu was completed in September. The plant had capability to produce up to 300 tons of sulfur per day from refinery effluent gas. The Petromin-Shell Saudi Arabia Refining Ltd. plant at Al Jubail, however, was not completed, but was expected to be operational early in 1985.

MINERAL FUELS

Coal.—At midyear, geologists working for the DMMR found Saudi Arabia's first outcropping of coal in a limestone quarry where weathering had previously made several seams undiscernible. Near Burayadah, northwest of Riyadh, the discovery rekindled interest in coal as a future fuel and for chemicals. Because chips of coal turn up in many water well bores stretching from the Empty Quarter on the south to the Jordanian border on the north, geologists feel that the possibilities of commercial coal deposits are very promising. In the summer of 1984, for example, chips of coal from 12 separate layers at deep levels showed up in water well drilling at Wasia near Rivadh. The coal source was Cretaceous rocks correlating with borehole findings in the Empty Quarter. Coal found in the Burayadah stone quarry tested at 13,500 British thermal units per pound. DMMR geologists felt that it will take 15 years to explore, map, and exploratory drill this huge coal prospect, which, if commercial, would match the English-French-Belgian-German coal region.

Natural Gas.—Proved recoverable reserves of natural gas continued a slow, steady increase, growing from 118 trillion cubic feet in early 1983 to 123 trillion cubic feet at yearend 1984.

Meanwhile, Saudi Arabia was proceeding rapidly throughout 1984 toward its goal of 1 billion cubic feet of nonassociated gas to be available for its domestic industrial and power requirements, including the burgeoning petrochemical industry.

On behalf of the Saudi Government, Aramco was drilling 27 wells through the oil and gas producing horizons in the Ghawar Field, Saudi Arabia's oldest and largest, to a depth of about 11,000 feet into the prolific Permian-age Khuff Formation, which lies beneath the Ghawar oil horizons. The Khuff gas was high-pressure, high-sulfur material requiring treatment. Gas was to be collected from these wells through a 137-kilometer gas gathering system and fed into existing gas treatment plants at Shedgum and Uthmaniyah, near the Ghawar Field. The sweetened and cleaned-up gas was then to be fed into the Master Gas System, allowing the system much greater flexibility in its deliveries to all its customers, some of whom had been on a very precarious edge for gas when Saudi Arabia's oil production was reduced so drastically in 1983-84.

Petroleum.—At mid-1984, the 4-year-old Iraq-Iran war appeared to have entered a serious new phase. Iran's military aircraft attacked, among many others by Iraq and Iran, a Saudi oil tanker, the Yanbu Pride, just 35 miles off the Saudi coast not far from Saudi Arabia's major oil export Port of Ras Tanura. This gave cause for concern that major Arab oil facilities at any random place along the Persian Gulf's west side might be next. Saudi Arabia accepted outside assistance in stepping up air defenses. Standard Oil Co. of California and Mobil were sufficiently alarmed that their tankers were told to stay out of the Persian Gulf. The gulf was not as important a source of oil as it was in the 1970's but still provided 20% of the market economy countries' oil supplies in 1984. Europe and Japan were still the largest users of oil originating at gulf ports.

Exploration.—Aramco sharply curtailed all drilling for exploratory purposes as well as development work on established productive structures. Except for active drilling of the deep Khuff gas formation, which was going forward rapidly, drilling was limited to about 110 wells, down markedly from the approximately 184 wells drilled in 1983. Emphasis remained on offshore fields that produced heavy and medium crudes. With tremendous reserves and a productive capacity about 2-1/2 times the daily production, there was little incentive to seek new reserves.

Production.—Petromin made a policy decision to restrict dissemination of petroleum statistics. Therefore, information from indirect sources is at best only educated estimates. The self-imposed curtailment of Saudi Arabia's crude oil production, which began in 1981, continued in 1984. From a

daily average production of about 9.6 million barrels in 1981, the 1984 daily production was 4.0 to 4.4 million barrels, which was off 9% from that of 1983 and was creating serious problems for Saudi Arabia's growth plans and programs because of sharply reduced oil sales income. Aramco, for the Saudi Government, continued producing about 90% of the country's crude, and the company was reporting production at its lowest level since 1970. This was beginning to affect the crude supplies of Aramco's four U.S. participants: Exxon Corp., Mobil, Standard Oil of California, and Texaco Inc., which were lifting about 1 million bbl/d, down from 7 million bbl/d in 1981, while Petromin was exporting about 2.2 million bbl/d, and placing additional crude in floating storage aboard huge tankers.

Activities in the Persian Gulf offshore Saudi Arabia continued fairly brisk. The huge, 31-year-old Safaniya Field, which produced from two sandstone reservoirs, was the site of construction of a 600,000-bbl/d desalting project costing $100 million and due on-stream by 1986. At a shipyard in neighboring Sharjah, Entrepose G.T.M. Pour Les Travaux Petroliers Maritimes (ETPM) was building 26 drilling platforms for Aramco, costing $20 million, for delivery early in 1985 to well sites in the Safaniya Field. Aramco was planning to proceed with a once-inactivated project for a sizable offshore oil and gas processing plant at Safaniya. Aramco reactivated a contract with Lummus Crest Inc. of Houston, Texas, for a preliminary design and bid package preparation for the 250,000-bbl/d offshore oil and gas production platform complex. The plant would also be handling 100 million cubic feet of gas per day. The complex was to include a main processing plant, an accommodation platform, and a platform containing manifolding and pipeline tie-in equipment. Plans called for oil and gas separation and gas compression and conditioning facilities and appropriate oil and gas pipelines to shore. Meanwhile, ETPM was also to build five tie-in platforms for Aramco in the Marjan offshore field. At Aramco's Qatif Field in the gulf, development of a waterflood project was under way. An underwater trencher was digging trench and laying a 6- to 8-inch pipe system, about 11 miles in all, including a shore approach and landing of the lines. Other wellhead platforms were being built for Aramco in Dubai and Abu Dhabi shipyards for use in Aramco's Marjan and Zuluf Fields.

During the year, Aramco discovered two new onshore oilfields at Farhah and Sahba while new deeper oil horizons were discovered offshore at the existing Marjan, Safaniya, and Zuluf Oilfields.

Refining.—At midyear, Aramco began awarding contracts on behalf of Petromin for various components of the new 150,000-bbl/d refinery to be built about 34 kilometers north of Burayadah in Saudi Arabia's Qasim region about 400 kilometers northwest of Riyadh. Designed to operate on heavy Saudi crude, the facility would make petroleum products for the domestic market. Saudi Arabian Bechtel Co. completed a feasibility study for the refinery late in 1982 and was to prepare detailed plans for the entire project. Saudi Arabia Toyo Engineering Co., the local affiliate of Japan's Toyo Engineering Co., was awarded an $8 million contract to build a 300-ton-per-day sulfur recovery plant at the refinery.

Work continued on the modernization work undertaken by Aramco on its Ras Tanura refinery, even as it continued in operation. Crude throughput averaged 400,000 bbl/d, and when the work is completed, the facility was to have a new 260,000-bbl/d crude unit and a 300-ton-per-day sulfur unit. Also, during the year, a dehydrator, a new asphalt tank farm, and loading docks for local use were put into service.

During the summer of 1984, Petromin announced that it planned to establish an international marketing network to promote spot and short-term sales of petroleum products from its new export refineries. The export services division was to be headquartered in London with branch sales offices in Houston, Texas; Geneva, Switzerland; and Tokyo, Japan. As Petromin's new export refineries increased their output, it was expected that about 20% of the petroleum products would be disposed of through spot and short-term deals.

One new export refinery, the PEM-REF facility at Yanbu, owned 50-50 by Petromin and Mobil, was started up in late July and loaded out its first shipment of products on behalf of Mobil on August 22, 1984. At the outset, the 250,000-bbl/d refinery ran at about 60% of capacity; crude was supplied from Saudi Arabia's Eastern Province fields through the Petroline crude pipeline. A huge power and desalination complex and the King Fahd Industrial Port and terminal on the Red Sea completed the gigantic new installation at Yanbu, which was inaugurated officially by Saudi Arabia's King on

October 2. The powerplants produce 250 megawatts of electricity per day, and the water plant will furnish 28.5 million gallons of freshwater per day to the new city of Yanbu.

Petrochemicals.—The world's petrochemical producers were carefully observing developments as Saudi Arabia's tremendous new producing capability began to move toward all-out production. Saudi Arabia's natural gas, previously flared as a waste product, was the primary feedstock to plants that soon would be producing 5% to 7% of the world's demand for petrochemicals. In 1984, world markets for these items were weak, and the world petrochemical industry registered deep concern.

There were 10 primary industry complexes either operating or under construction at Jubail during the year, and nearly all had something to do with petrochemicals. Most were joint ventures between the Saudi Basic Industries Corp. (SABIC) and a variety of international partners. At Yanbu, on the western side of Saudi Arabia, the huge ethylene plant of the Saudi Yanbu Petrochemical Co., a project of SABIC and Mobil, was completed ahead of schedule and under budget. The plant's output was to exceed a billion pounds per year, and employed state-of-the-art technology. Two principal products were to be polyethylene, which is used to make plastic bags and molded plastic products such as bottles, and ethylene glycol, a raw material used in the manufacture of certain fibers and automotive coolants. Mobil opened offices in 28 countries and an international marketing headquarters and technical services center in Brussels, Belgium, to handle the output from the Yanbu plant.

In addition to various basic plastic products from the group, at least one plant, Al Jubail Fertilizer Co., a joint venture of SABIC and Taiwan Fertilizer Co., was producing urea fertilizer for use in Saudi Arabia and in Bangladesh, China, India, Iran, Sudan, and Taiwan. SABIC also had established a worlwide marketing affiliate to handle sales, marketing, and technical services.

The new plant of the Saudi Petrochemical Co. (SADAF) at Jubail started test production of ethylene in the fourth quarter of 1984. Total cost of the SADAF project was estimated[3] to be $2.81 billion. Upon completion, the plant will have the capacity to produce annually 656,000 tons of ethylene, 456,000 tons of ethylene dichloride, 281,000 tons of crude industrial ethanol, 295,000 tons of styrene, and 377,000 tons of caustic soda. The Jubail plant was a 50-50 joint venture between SABIC and Pecten Arabia, an affiliate of U.S. Shell. U.S. Shell announced, late in the year, that it would take the plant's entire annual output of crude industrial ethanol, about 100 million gallons. This is about one-half the estimated U.S. annual demand for ethanol, which is used in solvents and coatings. Saudi Arabia has repeatedly stated that it hopes to capture 5% of the world's petrochemical market when all of its petrochemical plants are on-stream within a few years.

In December 1984, the Saudi-European Petrochemical Co. was established under an agreement signed by SABIC, the Arab Petroleum Investments Corp., Enichem of Italy, and Neste Oy of Finland. SABIC was to own 70% of the consortium's new plant, and each of the other three partners, 10%. The plant was to cost $600 million, and be constructed at Jubail. Using 700,000 tons per year of butane from Petromin and 170,000 tons per year of chemical-grade methanol from SABIC, the plant was to annually produce 500,000 tons of methyl tertiary butyl ether, 125,000 tons of butadiene, and 80,000 tons of butene-1.

Still another petrochemical complex was under way at Jubail. At the end of 1983, the National Plastic Co. (Ibm Hayyan) was established by SABIC, 70%; the Lucky Group of the Republic of Korea, 15%; and unidentified private sector investors, 15%. Construction began late in 1984 on the plant that will produce 300,000 tons of vinyl chloride monomer and 200,000 tons of polyvinyl chloride annually. Cost was expected to be about $400 million.

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[1]Physical scientist, Division of International Minerals.

[2]Where necessary, values have been converted from Saudi riyals (SRls) to U.S. dollars at the rate of SRls3.58 = US$1.00.

[3]Middle East Economic Survey (Nicosia, Cyprus). V. 28, No. 7, Nov. 26, 1984, p. A3.

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